COMMENTS OF THE SOCIETY OF BROADCAST ENGINEERS, INC.

MM DOCKET 93-225

IN THE MATTER OF AMENDMENT OF PART 73 OF THE COMMISSION'S RULES TO CLARIFY THE DEFINITION AND MEASUREMENT OF AURAL MODULATION LIMITS IN THE BROADCAST SERVICES

November 5, 1993

Society of Broadcast Engineers, Inc.
Indianapolis, Indiana

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Amendment of Part 73 of the	)	
Commission's Rules to Clarify	)	MM Docket No. 93-225
the Definition and Measurement	)	
of Aural Modulation Limits in the	)	
Broadcast Services	)	

To: The Commission

COMMENTS OF SOCIETY OF BROADCAST ENGINEERS, INC.

1. The Society of Broadcast Engineers, Incorporated (SBE), the national association of broadcast engineers and technical communications professionals, with more than 5,000 members in the United States, hereby respectfully submits its comments in the above-captioned Notice of Inquiry (NOI) relating to FM peak modulation.

SBE APPLAUDS COMMISSION ACTION TO ELIMINATE THE PRESENT UNCERTAINTY REGARDING FM PEAK MODULATION ISSUES

2. The SBE applauds this Commission action, as there is currently substantial uncertainty regarding allowable FM peak modulation levels. This uncertainty benefits no one. It is to both the Commission's advantage and to the advantage of SBE members who often act as designated Chief Operators, contract engineers, and duty operators, for there to exist FCC modulation rules that are clear and unambiguous.

3. The SBE agrees with the idea that an updated and more realistic occupied bandwidth criteria should be substituted for the present limit on peak modulation. The SBE will leave it to others, with greater laboratory and field measurement resources, to propose what the new, more restrictive occupied bandwidth criteria should be. The SBE will limit its comments to two issues which it believes will be critical to the success of a transition from peak modulation limits to occupied bandwidth limits.

4. First, the SBE believes that the Commission should only allow FM or TV stations that choose to install an occupied bandwidth monitor (OBM) and make this device continuously available at the operator's duty location, to forgo limits on peak deviation, and be bound only by

occupied bandwidth criteria. FM or TV stations that elect *not* to install an OBM should have to continue to monitor and limit their modulation pursuant to the existing limits on FM peak modulation.

5. Second, the SBE believes that nothing short of Commission Type Approval, and not Type Acceptance, Notification, or Certification, will be adequate to ensure a "level playing field" in the highly competitive arena of FM modulation levels. The SBE suggests that a Type Approved OBM be either a professional quality spectrum analyzer with a peak hold mode, such as those available from Hewlett Packard or Tektronix, or possibly a dedicated OBM, designed just for monitoring the occupied bandwidth of FM and/or TV aural signals. For professional-grade spectrum analyzers, a prescribed set of operating conditions should be specified: for example, a scan width of 20 kHz/division, a resolution bandwidth of 3 kHz, the fastest possible sweep speed recommended by the manufucturer for this combination of scan width and resolution bandwidth, no video filtering, a peak hold mode, and monitoring for at least a 10-minute interval. For a dedicated OBM, similar specifications should apply, although the instrument should not necessarily be required to have a cathode ray tube display.

6. The important points are that a specific universe of monitoring equipment with known, repeatable results be mandated, to ensure that all FM and TV stations are subject to the same limits and also to ensure that the operators who will be held accountable for the modulation levels at a station are guaranteed that they will be given the tool, in the form of a Type Approved OBM, to accurately set and monitor the station's modulation.

7. In the event an OBM becomes defective, the SBE suggests that this fact be noted in the Station Log, and, until the OBM is returned to service, the station must return to limiting its modulation on the basis of peak deviation rather than occupied bandwidth. Upon restoration of the OBM, a second log entry should be required, and at that point the station would once again be allowed to limit its modulation only on the basis of occupied bandwidth.

AVAILABLE ALGORITHMS FOR CALCULATING THE RF DOMAIN SPECTRA OF A COMPLEX FM SIGNAL

8. With regard to how the Commission should update its current admittedly crude limits on FM occupied bandwidth, the SBE notes that the computer program FMSIM by Quantics has been available from Broadcast Electronics since 1991. This software package calculates the RF domain spectra of complex FM signals, and appears to be exactly the sort of software that the

Commission inquires about at Paragraph 15 of the NOI. A two-page description of the FMSIM program is attached to these comments, as Figure 1.

9. The SBE similarly notes the existence of a program developed by Dr. Eric D. Stoll of Modulation Sciences, for the Hewlett Packard HP-41 programmable calculator, which can also calculate the occupied bandwidth in the RF domain of a complex FM signal with multiple subcarriers. A description of this program was printed in the June 15, 1984, issue of *Radio World*, at Page 13. An example of a modified and improved version of the Modulation Sciences program, with plotting capability added, is given in the attached Figure 2.

COMMISSION SHOULD CLARIFY MEASUREMENT TECHNIQUES FOR FM STATIONS STAYING WITH PEAK MODULATION CRITERIA

10. If any form of peak modulation limits are retained, the Commission needs to clarify two aspects of its January 31, 1991, public notice, "Modulation Measurement". Although the SBE appreciates that this public notice was issued in an attempt to resolve controversy that had arisen in the broadcasting industry regarding FM peak modulation measurements, it is the SBE's opinion that this notice raised more questions than it answered. The Commission should use this NOI as the forum to resolve those uncertainties, for those stations that must to continue to monitor modulation on the basis of peak deviation.

11. In the January 31, 1991, Notice, the Commission stated: "...it has been the experience of the Commission that all commercially manufactured monitors with which it is familiar produce satisfactory results which agree substantially the with Commission rules". The SBE believes that it would be helpful if the Commission would specifically state whether the Modulation Science's "Mod Minder" is one of the "commercially manufactured monitors with which it is familiar".

12. The SBE also believes that its members, as station engineers responsible for setting and maintaining modulation at FM broadcast stations, are entitled to a clear-cut, unambiguous answer to the following question: Are devices that only monitor peak modulation and intentionally ignore modulation peaks of less than one millisecond acceptable devices for monitoring peak modulation?

TV AURAL MODULATION

13. A related controversy has arisen regarding the measurement of TV aural modulation, especially by stations utilizing high-powered, common-mode TV transmitters, where the visual and

aural carriers are amplified in a common tube, as opposed to diplexed transmitters, where the visual and aural signals are amplified in separate tubes, and then combined using a diplexer. If special circuits are not included to limit the magnitude of H sync harmonics cross-modulating the aural signal, a frequency comb of spurious signals, beginning at 15.734 kHz, can modulate the aural carrier up to 25 kHz deviation (*i.e.*, 100% modulation for monophonic TV stations). This leaves a TV station with the Hobson's choice of reducing its main-channel (0-15 kHz) modulation so that the total modulation does not exceed 100%, thereby violating Section 73.1570(a) of the FCC Rules, which requires that program modulation levels be maintained between 85% and 100% on "peaks of frequent recurrence", or for the station to maintain 85-100% main channel modulation and allow the total modulation to exceed 25 kHz deviation, thus violating Section 73.1570(b)(3) of the FCC Rules.

14. In its comments to the Commission's November 30, 1990, Public Notice, "Hammett & Edison Request for Clarification Concerning TV Multiplexed Transmitters' Aural Performance", Television Technology Corporation suggested that, for monophonic TV stations, any modulation of the aural carrier caused by harmonics of the horizontal scanning frequency should simply be ignored. In its September 9, 1993, letter to Hammett & Edison, Inc., responding to this issue, the Commission stated:

> "With respect to modulation levels in general, observation of and conformance with the proper limits is primarily an operational requirement of the TV station licensee. It is clearly in the best interest of the licensee to select and operate its equipment so as to maximize the qualityof its signal and avoid overmodulation. The Commission's rules on modulation limits are clear and enforceable, and you noted in your filing, the Commission's Field Operations Bureau will issue a Notice of Violation when those rules are not followed (and contrary to TTC's suggestion, the aural modulation rule does not exclude consideration of incidental cross-modulation). The ultimate burden of proper operation of a television station lies with the station licensee."

15. The SBE believes that the Commission was correct to affirm that its TV aural modulation rules are clear and will be strictly enforced. Any signals that modulate the TV aural carrier should be counted towards the ±25 kHz deviation limit applying to monophonic TV stations. Further, the SBE believes that these signals, if present, should be summed on an arithmetic basis, as stipulated at Section D(b)(5), Page 11, of Office of Engineering and Technology OET Bulletin No. 60A, "Multichannel Television Sound Transmission and Audio Processing Reuqirements for the

BTSC System", February, 1986, and not a square root of the sum of the squares basis (RMS basis), as suggested by Acrodyne Corporation.

16. The SBE believes that FM modulation is inherently a voltage-domain phenomena, and not a power domain phenomena. For example, for the attached demodulated aural baseband spectrograph of a common-mode TV transmitter without a correction circuit to limit the cross-modulation between the visual and aural carriers, the arithmetic sum of the H sync spurs is 28.7%, which exceeds the 15% maximum that can be deduced from Section 73.1570(a) of the FCC Rules. If instead one is allowed to sum these spurious signals on an RMS basis, the total modulation of the aural carrier drops to 8.9%. If an RMS summation does not "solve" the problem of excessive H sync spurs, the SBE surmises that some manufacturers might then argue that the signals should be summed by taking the cube root of the sum of the cubes, in which case the undesired modulation drops to 6.2%. Still not good enough? Then try the fourth root of the sum of the quardics, in which case the total drops to 4.9%. The SBE believes that the Commission should use this NOI to establish that such artificial means to make a poorly designed common-mode TV transmitter appear to meet the Commission's Rules is unacceptable. The SBE believes that discrete frequency signals in the demodulated aural baseband, whether they are from intentional subcarrier generators or from unintentional H sync spurs, should always be summed on a voltage domain, or arithmetic, basis.

SUMMARY

17. The SBE applauds this NOI, which will hopefully eliminate the regulatory uncertainty now existing in the broadcasting industry. The SBE endorses the concept of having only an occupied bandwidth limit, but only if stations install an OBM and only if the OBM is FCC Type Approved. The SBE encourages the FCC to clarify two aspects of its January 31, 1991, Public Notice concerning FM peak modulation issues, and urges the Commission to adopt a strict stance on TV aural modulation issues.

LIST OF FIGURES AND EXHIBITS

The following figures or exhibits have been prepared as a part of these MM Docket 93-225 comments:

1. Manufacturer's literature describing Quantics' FMSIM software
2. Calculated FM bandwidth using Modulation Science's computer program
3. Common-mode TV transmitter demodulated aural baseband spectrograph.

Respectfully submitted,
Society of Broadcast Engineers, Inc.

By _____
Charles Kelly, President

By _____
Dane E. Ericksen, P.E.
Chairman, SBE FCC Filings Committee

By _____
Christopher D. Imlay, Its Counsel

November 5, 1993

Booth, Freret & Imlay
1233 20th Street, N.W., Suite 204
Washington, D.C. 20036
(202) 296-9100

FMSIM

$1500

FM Simulation Software

-by-

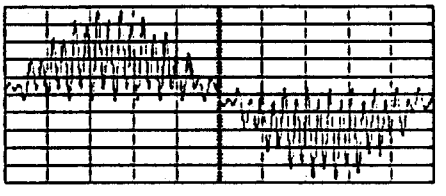
Quantics

P. O. Box 2163
Nevada City, California 95959

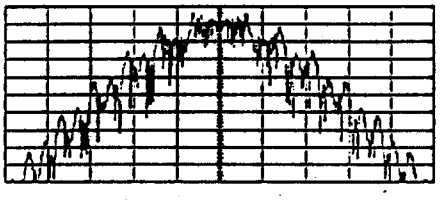
FMSIM is also available from:

Broadcast Electronics
P. O. Box 3606
Quincy, Illinois 62305
telephone (217) 224-9600

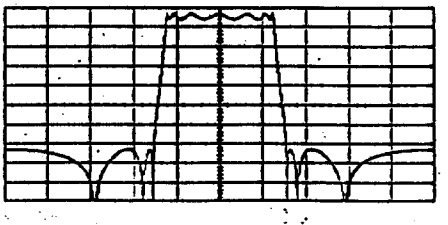
FMSIM is a powerful simulation and analysis tool for those working with broadcast FM stereo transmission and reception systems. FMSIM calculates signal degradation due to interference, signal filtering and multipath propagation. FMSIM produces accurate results for FM stereo modulation with SCA subcarriers, and eliminates the guesswork based on extrapolation of simple single-tone calculations.



Calculate time domain signals



Calculate RF spectra for complex modulation conditions



Built-in filter design facility (or provide your own filter data)

FMSIM quantitatively answers many difficult questions such as, "exactly what happens to my signal if I transmit stereo with two SCAs through a detuned overcoupled bandpass filter and then add a multipath reflection?" FMSIM saves time and money for broadcasters, consultants, and manufacturers of transmitters, STL systems, and antennas by accurately predicting performance and avoiding costly mistakes and experiments. Comparison of measured versus simulated performance allows system engineers to determine whether there may be an undiscovered bandlimiting mechanism. FMSIM can be of particular value in analyzing very low levels of distortion (less than 0.01%) where experimental error may dominate the measurement.

FMSIM System Requirements:
MS-DOS 2.0 or better
384k RAM
CGA, EGA, or VGA color graphics
Parallel Port

Optional (for hard copy):
EPSON MX, FX or compatible dot matrix printer

FMSIM is menu-driven and for the experienced FM engineer, little or no training is necessary to use the software.

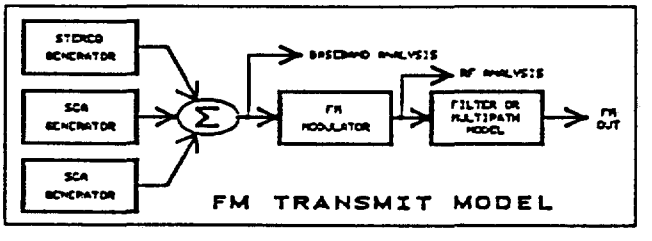
FMSIM begins by asking you for a set of modulation conditions (mono or stereo, modulating frequencies and percentages, SCA frequencies, modulation, and injection levels, etc.).

FMSIM then asks for filter information. You can either use FMSIM's built-in filter design facility (which does Butterworth, Chebychev, Elliptic, Bessel, ideal, or multipath functions) or you can specify your own tabulated filter data which might be derived from a SPICE model or from a network analyzer.

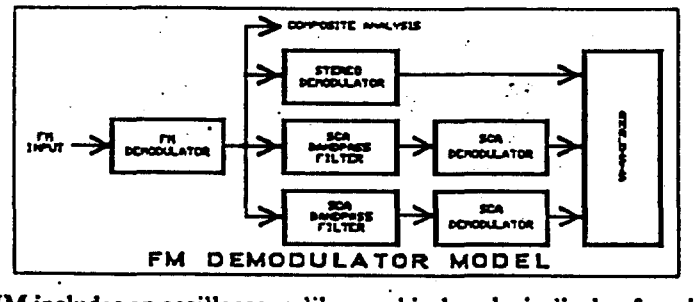
FMSIM also includes a script language for description of nonlinear filters. For example, to simulate a tuned class C amplifier, it could be modeled as the cascade of three functions: a singly tuned filter (grid or cathode circuit), a limiting device (nonlinear class C transfer characteristic), and a second order bandpass filter (doubly tuned output matching network). FMSIM simulation capability includes the following nonlinear functions: hard limiting, clipping, AGC, simple gain blocks, and piecewise linear (generalized) amplitude transfer functions.

FMSIM can also simulate co-channel interference. You can use FMSIM to create an interfering signal or you can create your own special interfering signals.

FMSIM then numerically modulates an FM carrier with your specified modulation conditions. The numerical model block diagram is the same as a hardware implementation:



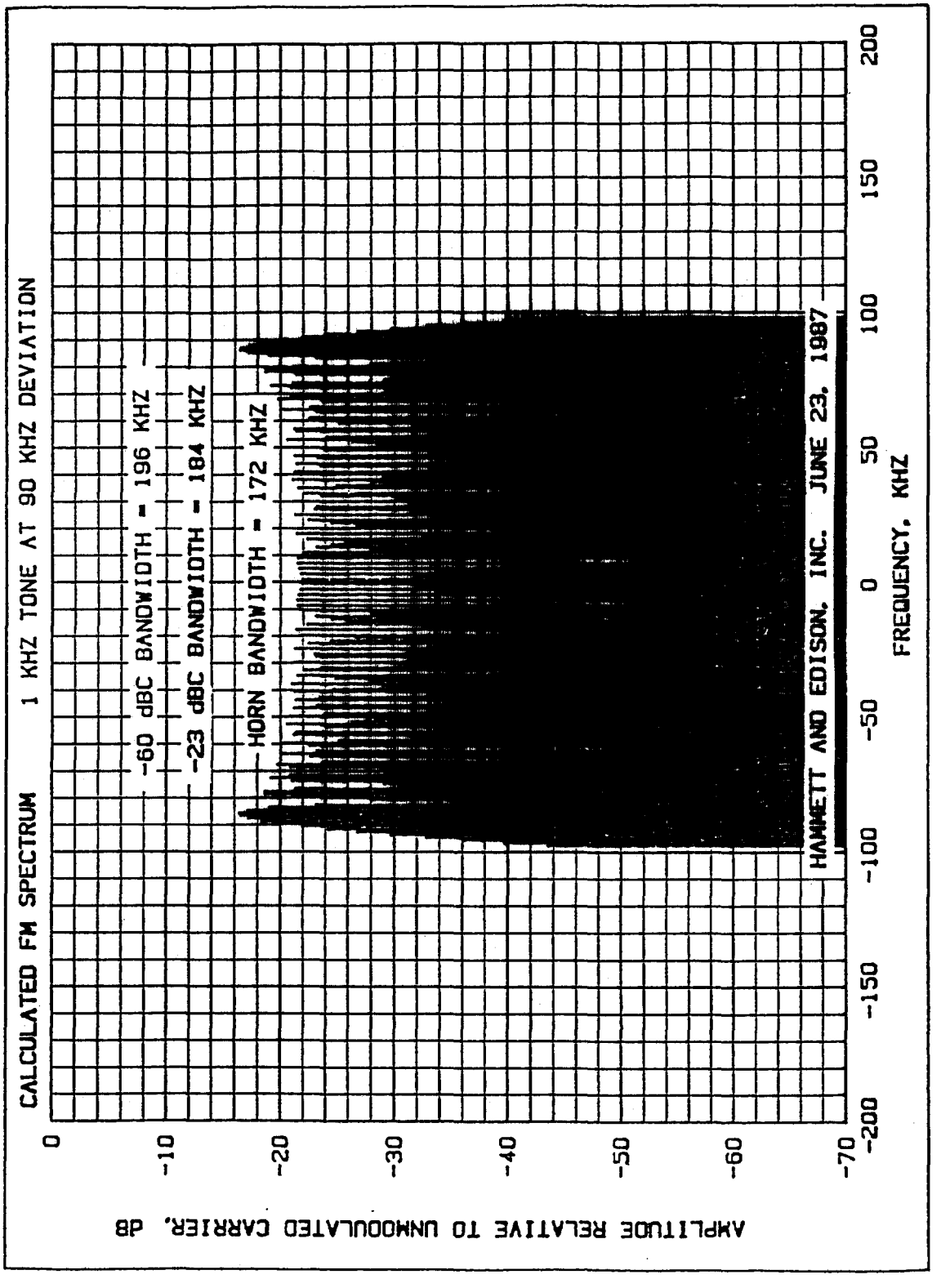
Next FMSIM filters the FM signal, demodulates it, and generates an extensive analysis of each signal component. In addition to the conventional distortion and separation values, many other results are calculated including pilot injection, incidental AM, SCA injection, incidental AM of SCA subcarriers, nonlinear separation components, etc. The FM detection and analysis equivalent block diagram is shown below.



FMSIM includes an oscilloscope-like graphical analysis display function which allows the user to look at a wide variety of time domain and frequency domain data. For example, it is possible to look at the FM RF spectrum, the demodulated composite spectrum, time domain left and right outputs, etc.

FMSIM is a "must-have" software tool for those involved in broadcast FM transmission and reception engineering.

EXAMPLE OF MODIFIED VERSION OF
MODULATION SCIENCE'S FM MODULATION PROGRAM



SBE

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FIGURE 2A

SBE COMMENTS TO
MM DOCKET 93-225

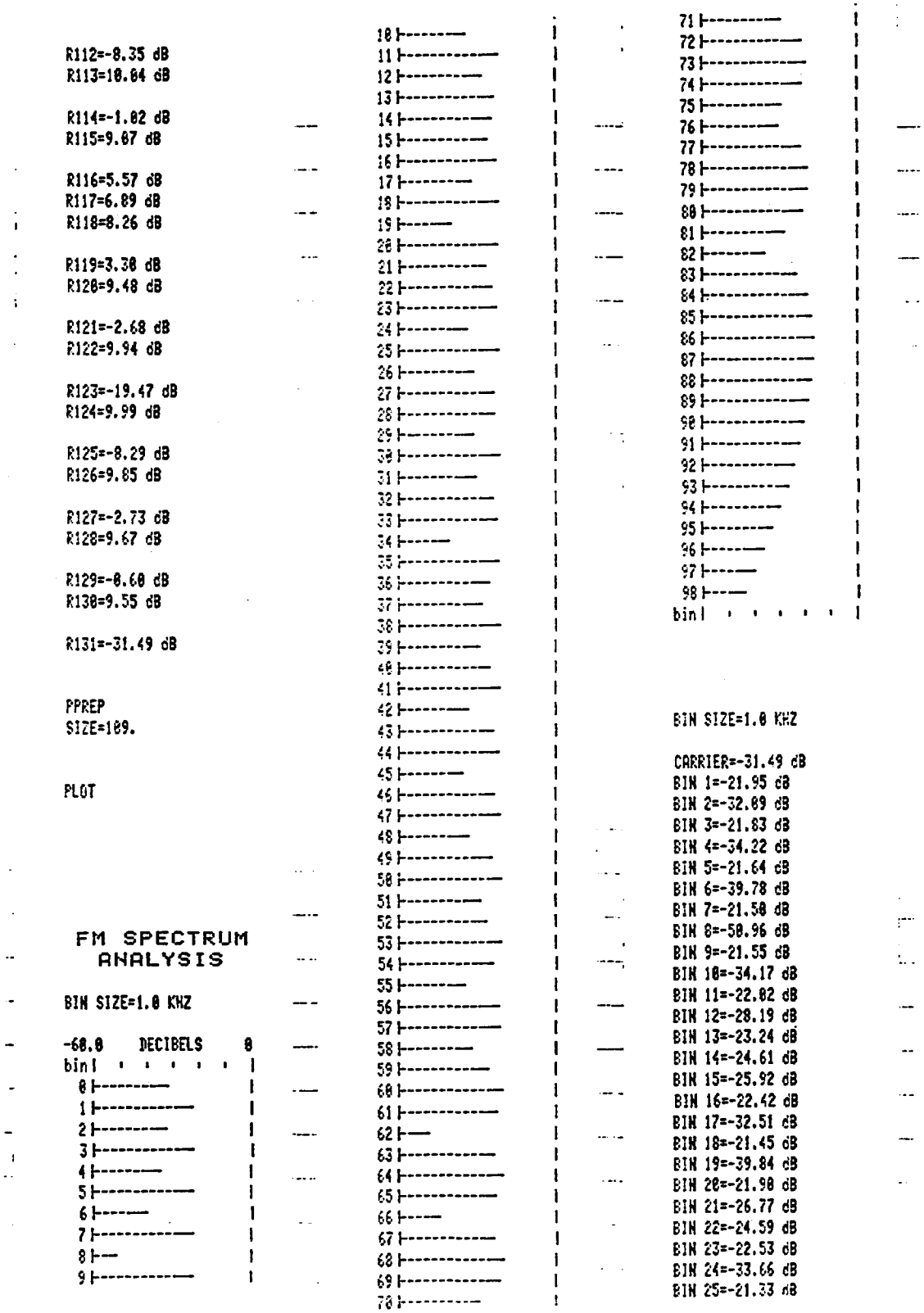
EXAMPLE OF MODIFIED VERSION OF
MODULATION SCIENCE'S FM MODULATION PROGRAM

```
          XROM "FMINP"

06/24/87
 7:36:52 AM


TY?
                    RUN
HR STEREO=?
              0     RUN
HR SINGLE=?
              1     RUN

SIZE=33

SNGL TI
FREQ, HZ?
           1000     RUN
INJ(%)=?
            120     RUN
RVW
 7:37:23 AM



TONE 1
FREQ 1000
INJ(%) 120.0
MOD IX 90.000
HR SB 98

STEREO MOD 0.0%
TOT MOD 120.0%

BIN SIZE, KHZ?
             1.0    RUN

SIZE=132


REG ALLOC

TI R33 - R131

SUP
 7:48:27 AM



SIZE=133

PAIR
 7:49:37 AM


3WAY
 7:50:22 AM


06/24/87
 7:50:31 AM
```

```
CHK
SIZE=231

Σ PWR=99.9943%

TONES:

R33=-12.65 dB
R34=-8.27 dB
R35=-4.70 dB
R36=-1.35 dB
R37=1.76 dB
R38=4.63 dB
R39=7.21 dB
R40=9.51 dB
R41=11.48 dB
R42=13.08 dB
R43=14.27 dB
R44=14.96 dB
R45=15.65 dB

R46=14.33 dB

R47=12.43 dB

R48=8.31 dB

R49=-4.23 dB
R50=3.42 dB
R51=10.32 dB
R52=12.78 dB
R53=12.79 dB

R54=10.11 dB

R55=1.00 dB
R56=2.33 dB
R57=10.30 dB
R58=12.30 dB

R59=10.59 dB

R60=2.24 dB
R61=2.57 dB
R62=10.59 dB
R63=11.70 dB

R64=7.70 dB

R65=-12.60 dB
R66=8.84 dB
R67=11.52 dB

R68=8.26 dB

R69=-16.90 dB
R70=8.89 dB
R71=11.20 dB
```

```
R72=6.27 dB

R73=-0.60 dB
R74=10.27 dB

R75=10.09 dB

R76=-2.80 dB
R77=7.31 dB
R78=10.80 dB

R79=5.12 dB

R80=3.03 dB
R81=10.65 dB

R82=7.50 dB

R83=-1.65 dB
R84=10.25 dB

R85=8.20 dB

R86=-4.00 dB
R87=10.09 dB

R88=7.96 dB

R89=-1.86 dB
R90=10.25 dB

R91=6.60 dB

R92=2.52 dB
R93=10.41 dB

R94=3.31 dB
R95=6.50 dB
R96=9.90 dB

R97=-9.37 dB
R98=9.24 dB

R99=7.83 dB

R100=1.17 dB
R101=10.24 dB

R102=0.21 dB
R103=8.27 dB
R104=8.42 dB

R105=0.09 dB
R106=10.16 dB

R107=-2.17 dB
R108=8.96 dB

R109=6.90 dB

R110=4.73 dB
R111=9.59 dB
```

EXAMPLE OF MODIFIED VERSION OF MODULATION SCIENCE'S FM MODULATION PROGRAM



SBE COMMENTS TO
MM DOCKET 93-225

EXAMPLE OF MODIFIED VERSION OF
MODULATION SCIENCE'S FM MODULATION PROGRAM

```
BIN 26=-31.40 dB
BIN 27=-23.07 dB
BIN 28=-23.22 dB
BIN 29=-31.29 dB
BIN 30=-21.25 dB
BIN 31=-30.32 dB
BIN 32=-23.66 dB
BIN 33=-22.26 dB
BIN 34=-40.86 dB
BIN 35=-21.52 dB
BIN 36=-25.00 dB
BIN 37=-28.19 dB
BIN 38=-21.08 dB
BIN 39=-28.97 dB
BIN 40=-24.81 dB
BIN 41=-21.24 dB
BIN 42=-33.35 dB
BIN 43=-23.53 dB
BIN 44=-21.40 dB
BIN 45=-35.57 dB
BIN 46=-23.29 dB
BIN 47=-21.24 dB
BIN 48=-33.14 dB
BIN 49=-23.99 dB
BIN 50=-20.84 dB
BIN 51=-28.47 dB
BIN 52=-26.37 dB
BIN 53=-20.61 dB
BIN 54=-24.18 dB
BIN 55=-34.38 dB
BIN 56=-21.40 dB
BIN 57=-21.23 dB
BIN 58=-32.69 dB
BIN 59=-25.23 dB
BIN 60=-20.29 dB
BIN 61=-22.60 dB
BIN 62=-40.40 dB
BIN 63=-23.24 dB
BIN 64=-19.98 dB
BIN 65=-22.65 dB
BIN 66=-44.17 dB
BIN 67=-23.79 dB
BIN 68=-19.79 dB
BIN 69=-20.90 dB
BIN 70=-20.93 dB
BIN 71=-29.25 dB
BIN 72=-20.90 dB
BIN 73=-19.19 dB
BIN 74=-21.12 dB
BIN 75=-29.16 dB
BIN 76=-30.49 dB
BIN 77=-21.38 dB
BIN 78=-18.70 dB
BIN 79=-18.72 dB
BIN 80=-21.17 dB
BIN 81=-20.80 dB
BIN 82=-35.72 dB
BIN 83=-23.19 dB
BIN 84=-19.06 dB
BIN 85=-17.16 dB
BIN 86=-16.44 dB
BIN 87=-16.53 dB
BIN 88=-17.23 dB
BIN 89=-18.41 dB
BIN 90=-20.02 dB
BIN 91=-21.90 dB
BIN 92=-24.20 dB
BIN 93=-26.87 dB
BIN 94=-29.73 dB
BIN 95=-32.84 dB
BIN 96=-36.19 dB
BIN 97=-39.76 dB
BIN 98=-43.54 dB

DONE

06/24/87
 8:14:23 AM

                FIX 9
                PRREG

R00=  98.00000000
R01=  99.00000000
R02=  99.00000000
R03=  99.00000000
R04=  138.0000000
R05=  4.000000000
R06=  10.00000000
R07=  109.0000000
R08=  1.000.000000
R09= -60.00000000
R10= -31.49257148
R11= -21.94627679
R12= -32.09211241
R13= -21.82705489
R14= -34.22077158
R15= -21.64366176
R16= -39.78010705
R17= -21.50130861
R18= -50.96425813
R19= -21.55340962
R20= -34.17495479
R21= -22.01692143
R22= -28.19344811
R23= -23.23613734
R24= -24.60697178
R25= -25.91853830
R26= -22.41799288
R27= -32.51414662
R28= -21.44808289
R29= -39.84270382
R30= -21.90070573
R31= -26.76530094
R32= -24.59339244
R33= -22.53340131
R34= -33.66032584
R35= -21.33355555
R36= -31.46489102
R37= -23.07015763
R38= -23.21858419
R39= -31.28635957
R40= -21.24872087
R41= -30.32266501
R42= -23.65941613
R43= -22.25531318
R44= -40.86174706
R45= -21.51711442
R46= -24.99630787
R47= -28.18586599
R48= -21.08100409
R49= -28.97229525
R50= -24.81434431
R51= -21.24357557
R52= -33.34787469
R53= -23.53233045
R54= -21.39783598
R55= -35.56004435
R56= -23.28898199
R57= -21.24395260
R58= -33.13963838
R59= -23.99144857
R60= -20.83008215
R61= -28.46549545
R62= -26.36836490
R63= -20.60762758
R64= -24.18269245
R65= -34.37727345
R66= -21.39809580
R67= -21.22579428
R68= -32.08911988
R69= -25.22547416
R70= -20.29125796
R71= -22.59855759
R72= -40.39737306
R73= -23.23516349
R74= -19.97674736
R75= -22.65866398
R76= -44.16994479
R77= -23.79196958
R78= -19.79340875
R79= -20.98326956
R80= -20.92673211
R81= -29.25307699
R82= -20.90010849
R83= -19.18897134
R84= -21.11596118
R85= -29.16001358
R86= -30.48879792
R87= -21.37945830
R88= -18.70397963
R89= -18.71756669
R90= -21.17025284
R91= -20.87708863
R92= -35.71953686
R93= -23.18696751
R94= -19.06019553
R95= -17.15704549
R96= -16.44468772
R97= -16.53238935
```

SBE

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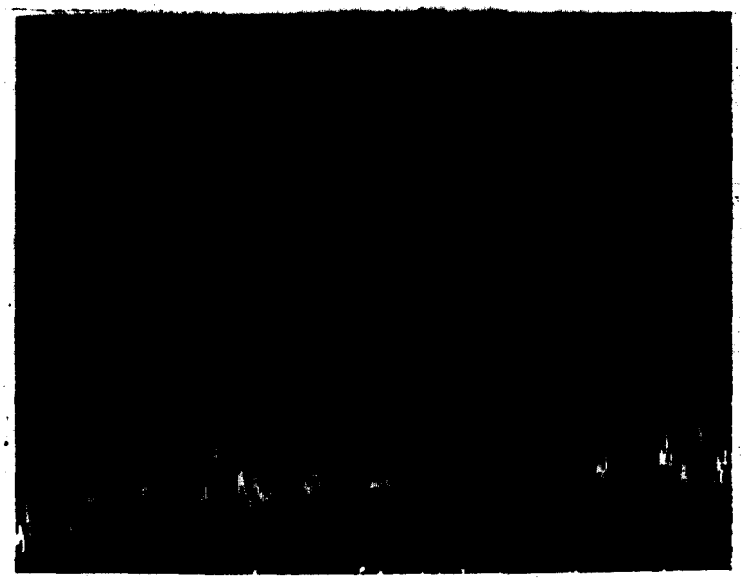
FIGURE 2D

DEMODULATED AURAL BASEBAND SPECTROGRAPH OF AN UNCORRECTED COMMON-MODE TV TRANSMITTER



Demodulated aural baseband spectrograph. Analyzer gain has been set so top of screen ($dB_{100\%}$) is equal to ±25 kHz frequency deviation. Vertical scale is 10 dB/division, so -20 dB below top of screen equals 10% modulation, -40 dB equals 1% modulation, -60 dB equals 0.1% modulation, etc. Horizontal scale is 20 kHz per division. Sweep rate is 1 second per division.

This spectrograph shows the following H sync spurs:

Frequency	Level	Percent Modulation
15.7 kHz	-32 $dB_{100\%}$	2.5%
31.4	-36	1.6
47.2	-32	2.5
62.9	-29	3.5
78.7	-29	3.5
94.4	-29	3.5
110.1	-31	2.8
125.9	-31	2.8
141.6	-31	2.8
157.3	-35	1.8
173.1	-41	0.9
188.8	-46	0.5
	Total	28.7%